METHOD AND APPARATUS FOR CORRECTING C1/PI WORD ERRORS USING ERROR LOCATIONS DETECTED BY EFM/EFM+ DECODING

BACKGROUND OF THE INVENTION

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1.   Field of the Invention

The present invention relates to an error-erasure correction of data reproduced from an optical disc device, and more particularly, to a method and system for correcting errors and erasures in modulated channel data by

10   indicating error locations at the time of demodulating the modulated channel data.

2.   Description of the Related Art

An optical disc, such as a compact disc (CD) or digital versatile disc

15   (DVD), is used for storing a large quantity of audio, video and/or other data information. When such information is recorded on the optical disc and read therefrom, noises can be generated. To correct errors due to the noises, in a DVD system a Reed-Solomon (R-S) product code is used as an error correction code, and an inner code (PI) of (182,172,11) and an outer code (PO) of

20   (208,192,17) are included in the R-S product code. Here, "182" of the inner code or "208" of the outer code represents a length of a code word, that is, the number of symbols which form a code word. "172" of the inner code or "192" of the outer code represents a length of message or information of a code word, that is, the number of symbols that form the information of a code word. "11"

and "17" each represent a minimum distance, called a minimum Hamming distance, of a code word.

A CD system uses a cross-interleave Reed-Solomon code (CIRC) as an error correction code. CIRC includes a C1 code of (32,28,5) and a C2 code of (28,24,5). In the C1 code or the C2 code, the first factor ("32" of the C1 code or "28" of the C2 code) represents the length of a code word, the second factor ("28" of the C1 code or "24" of the C2 code) represents the length of information of a code word, and the last factor, "5", represents the minimum distance of a code word.

There is a limit to the correction of the inner code (PI) and the outer code (PO) of a R-S product code and the C1 and C2 codes of a CIRC code. The correction limit is determined by the minimum distance of a code word. For example, if the number of errors in a code word is defined as "e", the number of erasures in the same code word as "v", and the minimum distance of the code word as "d", an error correction using the R-S product code for a DVD system or the CIRC code for a CD system can correct errors of the code word only if Equation 1 is satisfied.

$$2e + v < \text{Minimum Distance} \qquad (1)$$

Here, 'error' means that neither an error value nor an error location is known, and 'erasure' means that an error value is not known but an error location is known. The error value is determined by the difference between an original

symbol value and an erroneous symbol value corresponding to the original

symbol. The 'error location' is the location of an erroneous symbol. The

'erroneous symbol' means that an original symbol is damaged by noises

produced by data processing such as recording and reproducing.

5 Table 1 is a summary of characteristics of a R-S product code and a CIRC

code used in CD and DVD systems, respectively.

Table 1

Code	Format	Minimum Distance	Correctable Error Number	Correctable Erasure Number
CD C1 Code	(32,28,5)	5	2	4
CD C2 Code	(28,24,5)	5	2	4
DVD PI Code	(182,172,11)	11	5	10
DVD PO Code	(208,192,17)	17	8	16

10 Both the C1 code and C2 code have the minimum distance of "5", so that

with respect to the C1 and C2 codes, it is possible to correct up to two (2) errors

or four (4) erasures per each code word. If there are errors and erasures

together in a code word, it is possible to correct up to one (1) error and two (2)

erasures.

15 The PI code has the minimum distance of "11", so that it is possible to

correct up to five (5) errors or ten (10) erasures in a PI code word. The PO code

has the minimum distance of "17", so that it is possible to correct up to eight (8)

errors or sixteen (16) erasures in a PO code word.

The CD or DVD system uses a slicer to change an analog signal read from a CD or DVD into digital data. A conventional slicer changes an input sample signal into a binary number such as "1" (or logic high state) or "0" (or logic low state) using high and low threshold values between the two logic states.

5   In other words, a conventional slicer uses a "soft decision method" in which if an input sample signal is smaller than the low threshold value, it outputs "0", if the input sample signal is bigger than the high threshold value, it outputs "1", and if the input sample signal is between the high and low threshold values, it outputs an "erasure." Since the slicer outputs 14 bits (in the case of the CD) or 16 bits

10   (in the case of the DVD) data to form one symbol, use of the soft decision method in the slicer causes an increase in the number of the erasures. As a result, the actual efficiency of the error correction is lowered.

For these reasons, a C1 decoder or a PI decoder in a error correction system does not use the erasure correction in the error correction of a C1 word

15   or a PI word. An erasure flag can be obtained from the result of the error correction of the C1 or PI word in the C1 or PI decoder. A C2 decoder or a PO decoder uses the erasure flag in the erasure correction of a C2 word or a PO word. This is because the entire error correction efficiency is higher when the C2 or PO word is used for the erasure correction than when the C2 or PO word is

20   used for the error correction.

In a conventional error correction system, therefore, it is possible to error-correct up to 2 erroneous symbols per each code word for a C1 code, and it is possible to erasure-correct up to 4 erroneous symbols per each code word for a

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C2 code. Similarly, it is possible to error-correct up to 5 erroneous symbols per each code word for a PI code, and it is possible to erasure-correct up to 16 erroneous symbols per each code word for a PO code.

However, for high speed optical devices such as a high speed CD-ROM and a high speed DVD-ROM, high speed data processing is required when restoring data from such media. The incidence of errors in a high speed data processing is higher than the incidence of errors in a low speed data processing.

Therefore, a need exists for an error correction system which is more efficient and effective in the error correction than a conventional error correction system in a high speed as well as a low speed data processing.

SUMMARY OF THE INVENTION

Accordingly, to solve the above and other problems, it is an object of the present invention to provide a method for performing more effective error correction by indicating error locations and for performing error-erasure correction on code words in which error locations are indicated at the time of demodulating modulated data reproduced from an optical disc.

It is the other object of the present invention to provide a system for more effectively correcting errors and erasures in the code words in which error locations are indicated at the time of demodulating modulated data reproduced from an optical disc.

To achieve the above and other objects, a method for channel-decoding and error-correcting modulated data reproduced from an optical disc according

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to the present invention includes: (a) determining a channel code including channel data patterns that channel data symbols can have, and channel data symbols that correspond individually to the channel data patterns; (b) producing modulated data including information data symbols and erasure flags by

5   demodulating the channel data symbols, using the determined channel code; and (c) performing an error-erasure correction on the information data symbols produced in the step (b), using error locations indicated by the erasure flags having a predetermined value. Preferably, the step (b) includes: (b1) outputting the information data symbols if the channel code has the information data

10   symbols corresponding to the channel data symbols; and (b2) outputting erasure symbols as the above information data symbols and setting the erasure flags to the predetermined value if the channel code has no information data symbols corresponding to the channel data symbols.

   To achieve other objects of the present invention, a system for channel

15   decoding and error correcting modulated data reproduced from an optical disc includes: a channel code including channel data patterns which can have channel data symbols and the information data symbols corresponding to the channel data patterns individually; a channel decoder producing demodulated data including the information data symbols and the erasure flags by

20   demodulating the channel data symbols, using the channel code; a memory storing the demodulated data outputted from the channel decoder; and a decoding unit for performing an error-erasure correction on the information data symbols, using error locations indicated by the erasure flags having a

predetermined value. In the system, if information data symbols corresponding to the channel data patterns exist in the channel code, the channel decoder outputs the corresponding information data symbols as the information data symbols. If information data symbols corresponding to the channel data patterns

5   do not exist in the above channel code, the channel decoder outputs the erasure symbols as the information data symbols, and sets the erasure flags to the predetermined value.

BRIEF DESCRIPTION OF THE DRAWINGS

10   The above and other objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

FIG. 1 is a circuit diagram illustrating a conventional system for channel decoding and error correcting;

15   FIG. 2 is a circuit diagram illustrating a system for channel decoding and error correcting according to a preferred embodiment of the present invention;

FIG. 3 shows the differences between demodulated data in the conventional system in FIG. 1 and in the system of the present invention in FIG. 2;

20   FIG. 4 shows examples of the C1 word on which the system of the present invention in FIG. 2 performs error-erasure correction;

FIG. 5 shows an example of a PI word on which the system of the present invention in FIG. 2 performs error-erasure correction; and

FIG. 6 is a flowchart illustrating a method for channel decoding and error correcting according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

5   Before describing the preferred embodiments of the present invention, a conventional system for error correcting used in a CD system will be described with reference to FIG. 1.

In FIG. 1, an EFM decoder 11 receives EFM modulated channel data reproduced from a CD, and has an EFM code in the form of an internal lookup

10   table. The EFM code defines 256 channel data patterns that channel data symbols (CH_D) can have, and 8-bit information data symbols that corresponds to the channel data patterns individually. If there is a channel data pattern corresponding to a 14-bit channel data symbol (CH_D) of the EFM modulated channel data, the EFM decoder 11 chooses an 8-bit information data symbol

15   corresponding to the channel data pattern as an EFM demodulated data symbol (EFM_D).

If there is no channel data pattern corresponding to the channel data symbol (CH_D) in the EFM code, the EFM decoder 11 chooses any information data symbol within the EFM code as the EFM demodulated data symbol

20   (EFM_D), or chooses a predetermined information data symbol within the EFM code, for example, "0xFF." Therefore, all channel data symbols (CH_D) each having no corresponding channel data pattern will appear as errors in a subsequent error correction process.

The EFM decoder 11 provides 8-bit EFM demodulated data symbols (EFM_D), that is, the information data symbols, to a buffer memory 15 through a bus 13. The buffer memory 15 stores information data symbols provided from the EFM decoder 11. The buffer memory 15 provides a C1 word (C1_W),

5   formed of even-numbered information data symbols of a frame having 32 information data symbols and odd-numbered information data symbols of the next frame, to a C1 decoder 17 through the bus 13.

The C1 decoder 17 which receives the C1 word (C1_W) performs an error correction on the received C1 word (C1_W), using 4 P-parity symbols included in

10   the C1 word (C1_W). Therefore, the C1 decoder 17 can correct one erroneous information data symbol per code word formed of 28 information data symbols. If there are two (2) or more erroneous information data symbols in one code word, the C1 decoder 17 attaches erasure flags to the code word. Accordingly, for example, the erasure flags each having a value of "1" are attached to all

15   information data symbols forming the code word. As a result, the C1 decoder 17 produces 9-bit data symbols (C1_D) each including an 8-bit information data symbol and an 1-bit erasure flag, and the 9-bit data symbols (C1_D) are provided to the buffer memory 15.

The buffer memory 15 performs a convolutional de-interleaving process

20   on the data symbols (C1_D) received from the C1 decoder 17. In the convolutional de-interleaving process, each of the 28 data symbols (C1_D) of one code word is delayed by a different time period, so that a C2 word (C2_W), formed of 28 data symbols (C1_D) obtained one by one from each of 28 code

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words, is produced. The convolutional de-interleaving process in the buffer memory 15 disperses the data symbols (C1_D) of the code word to which the erasure flags are attached by the C1 decoder 17, into 28 C2 words (C2_W).

Then, the 9-bit data symbols (C1_D) forming a C2 word (C2_W) are

5   transmitted to a C2 decoder 19 through the bus 13. Here, the C2 word (C2_W) provided from the buffer memory 15 to the C2 decoder 19 includes 28 data symbols (C1_D), and each data symbol (C1_D) includes an information data symbol and an 1-bit erasure flag.

The C2 decoder 19 decides whether each of the information data symbols

10   of a C2 word is an erasure symbol based on a corresponding erasure flag. If the information data symbols are erasure symbols, the C2 decoder 19 performs an erasure correction with respect to the information data symbols (i.e., the erasure symbols).

Upon performing the erasure correction, 8-bit information data symbols

15   are outputted from the C2 decoder 19 and provided to the buffer memory 15 where the information data symbols are de-interleaved. This completes the CIRC decoding by the apparatus for error correcting shown in FIG. 1.

A method and/or system of error correcting for a DVD system is similar to the method and/or system above described in reference to FIG. 1. The

20   difference between a CD system and a DVD system is that the DVD system uses a 8 to 16 modulated code (EFM+ code) as a channel code, and uses a PI code and a PO code for error correcting instead of the C1 code and the C2 code.

The EFM+ modulated data is error-corrected by a PI decoder, and the data error-corrected by the PI decoder is erasure-corrected by a PO decoder.

In a decoding process using the CIRC code or the R-S product code, if an error location within a code word can be known, the code word can be erasure-

5   corrected. Thus, in this case, more erasures than the number of correctable errors can be corrected. Therefore, it is desirable to know the error location within a code word in order to increase the error correction efficiency using the CIRC code and the R-S product code.

A basic concept of the present invention is using the C1 code or the PI

10   code for correcting erasures, using the characteristics that the channel data symbols which do not have the corresponding channel data patterns in the channel code are erroneous symbols. The error patterns which can be produced while recording and reproducing data in a CD/DVD are analyzed as follows:

Case 1: there are no channel data patterns corresponding to the

15   EFM/EFM+ modulated channel data symbols within the EFM/EFM+ code.

Case 2: there are corresponding channel data patterns within the EFM/EFM+ code even though the EFM/EFM+ modulated channel data symbols are changed by noises.

In Case 1, it can be decided that there are errors in the channel code

20   demodulated information data symbols before starting the error correction, so that it is possible to indicate the error location within a code word. On the other hand, in Case 2, it cannot be known whether there are errors in the demodulated information data symbols and the error location before the error correction is

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finished. Accordingly, if the conventional error correction method is simply performed on both Case 1 and Case 2, it is only possible to correct 2 errors in the case of a CD and 5 errors in the case of a DVD. If there are more errors than that, it is not possible to correct the errors.

5　　　　In the application of a high speed CD-ROM/DVD-ROM which requires high speed operation, the incidence of errors occurring when data is restored from an optical disc is higher in the high speed operation than in a low speed operation. In other words, under the circumstances such as the high speed operation, channel data symbols having no corresponding channel data patterns

10　in the EFM/EFM+ code are frequently produced. In this case, C1 decoding cannot correct 3 or more errors on a C1 word, PI decoding cannot correct 6 or more errors on a PI word. Consequentially, many code words that cannot be corrected are produced. However, if the Cases 1 and 2 are treated differently, the error correction efficiency can be increased.

15　　　　According to the present invention, an error of Case 1 is considered as an erasure since an error location (i.e., a location of the error) can be known, while an error of Case 2 is considered as an error since error value and location are not known. In this case, the erasure correction can be performed on the C1 word and PI word. In other words, the C1/PI decoder can perform the erasure

20　correction as well as the error correction with respect to a C1/PI word. As a result, the error correction where the C1/PI decoder performs both the error correction and the erasure correction is more efficient and effective than the error correction where the C1/PI decoder performs only the error correction. In

addition, since the incidence of Case 1 is higher than that of Case 2, the entire

error correction becomes further efficient.

FIG. 2 shows a system for channel decoding and error correcting

according to a preferred embodiment of the present invention. The system for

5   channel decoding and error correcting includes a channel decoder 21, a bus 23,

a buffer memory 25, and means for error correcting 27, 29.

The system of FIG. 2 can be realized as a system for channel decoding

and error correcting only for the CD, only for the DVD, or for a combined use of

the CD and DVD. Therefore, to avoid redundancy, the system for a combined

10   use of the CD and DVD will be described. The system in Fig. 2 uses the EFM

code and the CIRC code for the CD, and uses the EFM+ code and the R-S

product code for the DVD. Accordingly, the channel decoder 21 is preferably an

EFM/EFM+ decoder. Hereinafter, the channel decoder 21 is called the

EFM/EFM+ decoder.

15   The EFM/EFM+ decoder 21 has a channel code in the form of an internal

lookup table. The channel code includes an EFM code which is used for the CD

and an EFM+ code which is used for the DVD. In the case of use for the CD, the

EFM/EFM+ decoder 21 outputs 9-bit demodulated data (N_EFM_D) by EFM

demodulating 14-bit channel data symbol (CH_D) reproduced from the CD.

20   Preferably, the 9-bit demodulated data (N_EFM_D) is formed of 8-bit EFM

demodulated information data symbol (INF) and 1-bit first erasure flag (FLAG1).

The EFM demodulated information data symbols (INF) can have 256 patterns.

Therefore, 14-bit channel data symbols (CH_D) also have only 256 channel data

patterns. If there is no channel data pattern corresponding to a 14-bit channel data symbol (CH_D), the EFM/EFM+ decoder 21 outputs an erasure symbol as an information data symbol (INF) corresponding to the channel data symbol (CH_D).

5   If the EFM code is used as the channel code, the erasure symbol is chosen from the channel code or is a predetermined information data symbol (INF), for example "OxFF", present in the channel code.

In the case of the DVD, the EFM/EFM+ decoder 21 demodulates 16-bit channel data symbols (CH_D) reproduced from a DVD, and outputs the 9-bit

10   demodulated data (N_EFM_D). Preferably, the 9-bit demodulated data (N_EFM_D) is formed of an 8-bit EFM+ demodulated information data symbol (INF) and an 1-bit first erasure flag (FLAG1). In the case of the EFM+ code, the EFM+ demodulated information data symbols (INF) can have 256 patterns. Therefore, the 16-bit channel data symbols (CH_D) also have only 256 channel

15   data patterns. If there is no channel data pattern corresponding to a 16-bit channel data symbol (CH_D), the EFM/EFM+ decoder 21 outputs an erasure symbol as an information data symbol (INF) corresponding to the channel data symbol (CH_D). Preferably, if the EFM+ code is used as the channel code, the erasure symbol is a predetermined information data symbol (INF) present in the

20   channel code, for example, "OxFF." All the information data symbols (INF) within the EFM+ code, except for the specific information data symbols (INF) which are considered errorless during correction of errors, can be used as the erasure symbols.

To differentiate the erasure symbols from the information data symbols

(INF) obtained by demodulating the channel data symbols (CH_D) of which

corresponding channel data patterns exist in the channel code, the EFM/EFM+

decoder 21 sets the first erasure flag (FLAG1) as a prescribed value, for

5   example, "1", and attaches it to the information data symbols (INF). As a result,

the demodulated data (N_EFM_D) which is output from the channel decoder 21

is formed of the 8-bit information data symbols (INF) obtained from the channel

code and the 1-bit first erasure flag (FLAG1). FIG. 3 shows the difference

between the output (FIG. 3 (a)) of the EFM decoder 11 shown in FIG. 1 and the

10   output (FIG. 3 (b)) of the EFM/EFM+ decoder 21 according to the present

invention.

The buffer memory 25 performs a similar operation to the buffer memory

15 of FIG. 1. A C1 word or a PI word (N_C1_W/N_PI_W) is obtained from the

buffer memory 25 by performing the substantially same operation as the C1 word

15   (C1_W) is obtained from the buffer memory 15 in Fig. 1. The C1 or PI word

(N_C1_W/N_PI_W) is provided to the C1/PI decoder 27. The C1 or PI word

(N_C1_W/N_PI_W) includes the demodulated data (N_EFM_D) formed of the 8-

bit information data symbols (INF) and the 1-bit first erasure flag (FLAG1).

The C1/PI decoder 27 which receives the C1/PI word (N_C1_W/N_PI_W)

20   determines the information data symbols (INF) associated with the first erasure

flag (FLAG1) of which the value is 1 to be the erasure symbols. After the

erasure correction is performed on the erasure symbols, the error correction is

performed on the entire information data symbols forming the C1/PI word

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(N_C1_W/N_PI_W). Therefore, the C1/PI decoder 27 can correct one

erroneous information data symbol or up to 4 erasure symbols on the C1 word

(N_C1_W).FIG. 4 shows examples of the C1 word (N_C1_W) on which the

C1/PI decoder 27 in FIG. 2 performs the error correction. In FIG. 4, a

5   quadrangle indicated as "FF" means the demodulated data (N_EFM_D) to which

the first erasure flag is attached for indicating the error location, and a

quadrangle indicated as "ERR" means the demodulated data (N_EFM_D) which

cannot know whether it is an error or not. FIG. 4(a) is the case in which there

are 4 known error locations (FF) among the 32 demodulated data (N_EFM_D),

10   and FIG. 4(b) is the case in which there are 3 known error locations (FF). FIG.

4(c) is the case in which there are 2 known error locations (FF) and one error

location of the demodulated data (ERR) is not known even though it is an actual

error. Here, the actual error means that even though an error is produced, there

is a channel data pattern which is matched to the EFM code.

15   In the case of FIG. 4(c), if the conventional 2 error corrections are

performed, error correction becomes impossible, but it is possible to correct

errors using the erasure correction. The C1/PI decoder 27 can correct up to 5

erroneous information data symbols or 10 erasure symbols on the PI word

(N_PI_W) in which errors and erasures are mixed up.

20   FIG. 5 shows an example of the PI word (N_PI_W) on which the C1/PI

decoder 27 in FIG. 2 performs the error correction. The PI word (N_PI_W) in

FIG. 5 is formed of 182 information data symbols (INF), in which four (4) are

erasures (FF) and one is erroneous information data symbol (ERR) which is an

actual error but the error location is not known. When the errors and erasures are mixed up in the PI word (N_PI_W), the error number and the erasure number which the C1/PI decoder can correct at the same time are shown in the following table 2.

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Table 2

Error Number	Correctable Erasure Number
0	10 or less
1	8 or less
2	6 or less
3	4 or less
4	2 or less
5	0 or less

In the case of PI code, the correction capability of the code is relatively high compared to that of the C1 code used for the CD, so that a higher error

10 correction efficiency can be obtained.

Like the C1 decoder 17 in FIG. 1, if 2 or more erroneous information data symbols exist in one C1 word (N_C1_W), or 6 or more in one PI word (N_PI_W), the C1/PI decoder 27 attaches the second erasure flags (FLAG2) to the code word. Therefore, the second erasure flags (FLAG2), for example, having a value

15 of 1, are attached to all the information data symbols (INF) forming the code word.

The 9-bit data symbols (N_C1_D/N_PI_D) including the 8-bit information data symbols (INF) and the 1-bit second erasure flag (FLAG2) are provided to

the buffer memory 25. The buffer memory 25 performs the de-interleaving on the data symbols (N_C1_D/N_PI_D) received from the C1/PI decoder 27. The buffer memory 25 performs the convolutional de-interleaving in the case of use for the CD. In the case of use for the DVD, the buffer memory 25 performs the

5   de-interleaving and forms the PO word (N_PO_W) formed of 208 9-bit data symbols.

The C2/PO decoder 29 in FIG. 2 corrects errors on the C2 word or the PO word (N_C2_W/N_PO_W) provided from the buffer memory 25. The error correction by the C2/PO decoder 29 includes the erasure correction and it is

10   same as explained in FIG. 1.

As mentioned above, the error correction can be performed more effectively by indicating the error location during the demodulation of the modulated data using the channel code, and then error-erasure correcting the error location indicated in the code words.

15   FIG. 6 is a flowchart showing the method for channel decoding and error correcting according to a preferred embodiment of the present invention. The method for channel decoding and error correcting may be applied to the system in FIG. 2.

First, a channel code is set up (620). The channel code includes the

20   channel data patterns which the channel data symbols (CH_D) can have, and the information data symbols (INF) which corresponds individually to the channel data patterns. It is preferable that the channel code is set up previously in the

form of a look-up table in a channel decoder. For the channel decoder, the EFM code is used for the CD, and the EFM+ code is used for the DVD.

Second, the demodulated data (N_EFM_D) including the information data symbols (INF) and the first erasure flag (FLAG1) is produced by demodulating

5   the received channel data symbols (CH_D) (630) using the set-up channel code. The demodulated data (N_EFM_D) is preferably formed of the EFM/EFM+ demodulated 8-bit information data symbols (INF) and the 1-bit first erasure flag (FLAG1). This process (630) can be divided into the following detail processes.

First of all, it is determined whether the information data symbols (INF)

10   corresponding to the received channel data symbols (CH_D) exist in the channel code (631). If the information data symbols (INF) corresponding to the received channel data symbols (CH_D) exist in the channel code, the corresponding information data symbols are output as the information data symbols (INF) of the demodulated data (N_EFM_D) (633). If the information data symbols (INF)

15   corresponding to the received channel data symbols (CH_D) do not exist in the channel code, the erasure symbols are output as the information data symbols (INF), and the first erasure flag (FLAG1) is set to a predetermined value, for example, "1" (633). The erasure symbol may be chosen arbitrarily from the channel code or a predetermined information data symbol (INF) present within

20   the channel code, for example, "OxFF."

Third, the first error-erasure correction is performed (640). The first error-erasure correction is performed in the C1 decoding for the CD and in the PI decoding for the DVD. In this process (640), the information data symbols (INF)

corresponding to the first erasure flag (FLAG1) of the value 1 are judged as the

erasure symbols, and after performing the erasure correction on the erasure

symbols, the error correction is performed on the entire information data symbols

forming one code word.

5   Last, the second error-erasure correction is performed (650). This

process (650) can be divided into the following detail processes. First of all, it is

determined whether it is possible to correct the code word obtained from the first

error-erasure correction performed in the above process 640 (651). If it is not

possible to correct the code word, it means that there are more errors in the code

10   word than the number of correctable errors. For example, this is a case in which

there are two or more erroneous information data symbols in one C1 word

(N_C1_W), or 6 or more erroneous information data symbols in the PI word

(N_PI_W).

         If it is not possible to correct the code word, the second erasure flags

15   (FLAG2) are attached to the relevant code word. Therefore, the second erasure

flags (FLAG2), for example, having a value of 1, are attached to all the

information data symbols (INF) forming the code word. Preferably, the de-

interleaving is performed on the 9-bit data symbols including the 8-bit information

data symbols and the 1-bit second erasure flag (FLAG2). Then, the second

20   error-erasure correction is performed (655). The second error-erasure correction

is performed using the second erasure flags in the C2 decoding for the CD, and

in the PO decoding for the DVD.

Having described the preferred embodiments of the system and method for channel decoding and error correcting according to the present invention, modifications and variations can be readily made by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the

5   scope of the appended claims, the present invention can be practiced in a manner other than as specifically described herein.